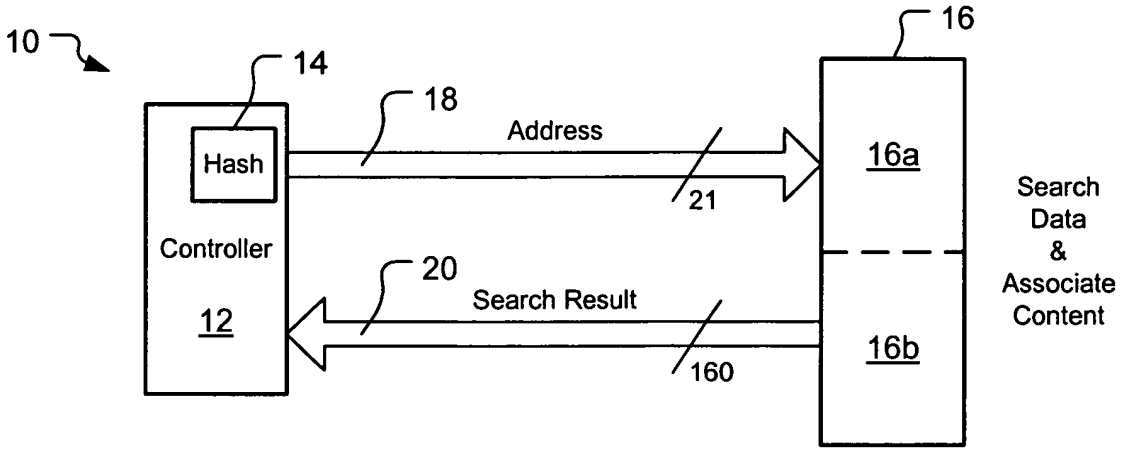


FIG. 1 (background art)

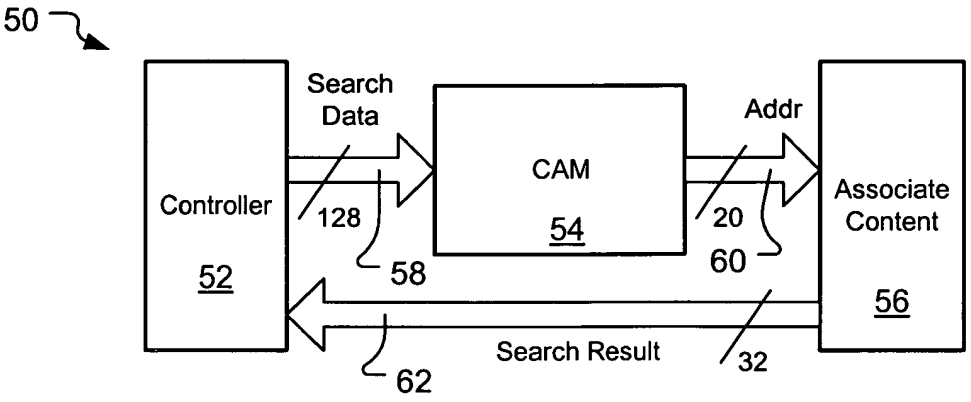


FIG. 2 (background art)

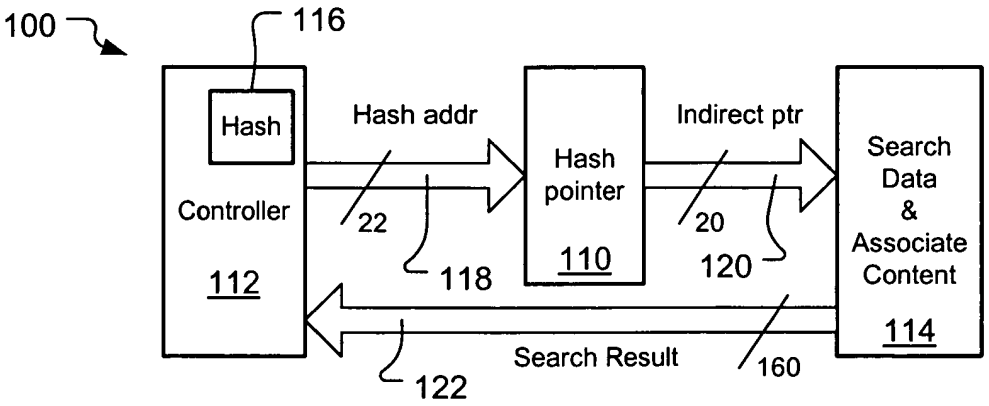


FIG. 3

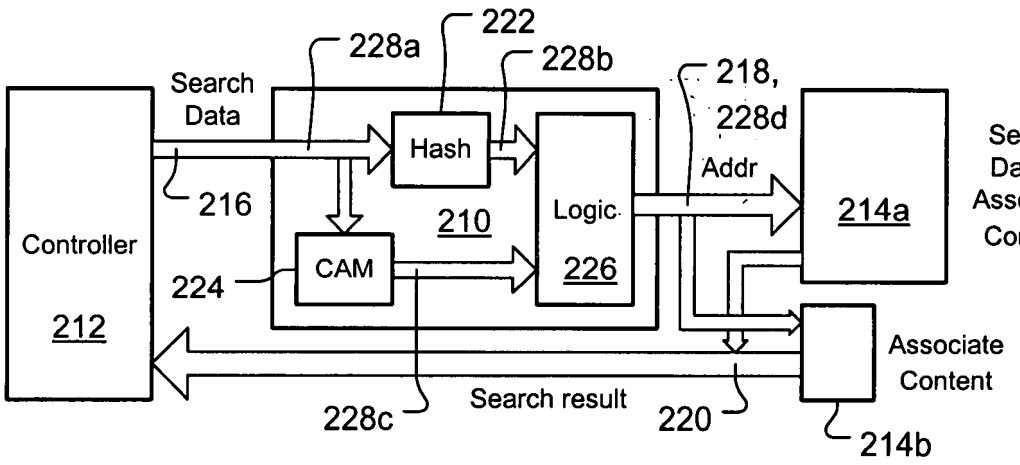


FIG. 4

Paths: a ≥ b ≅ d;

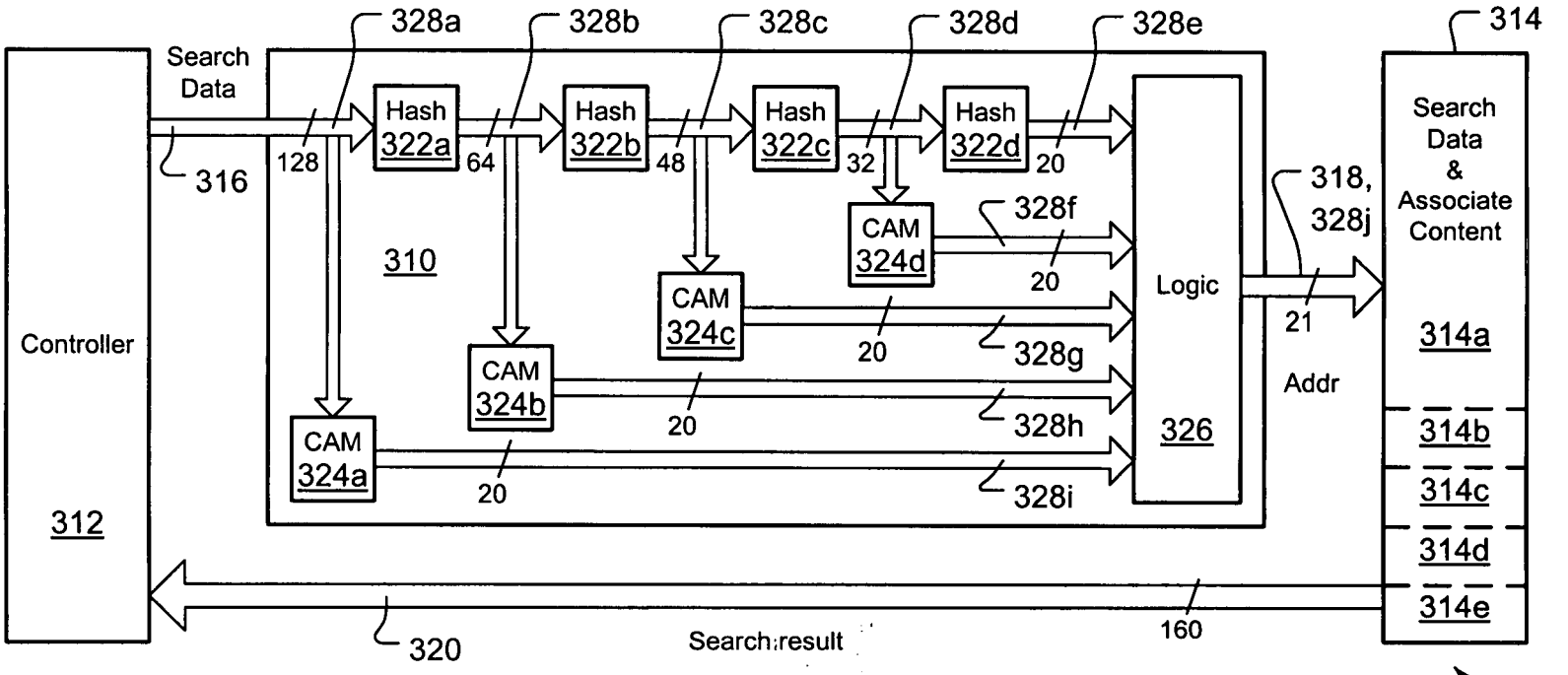


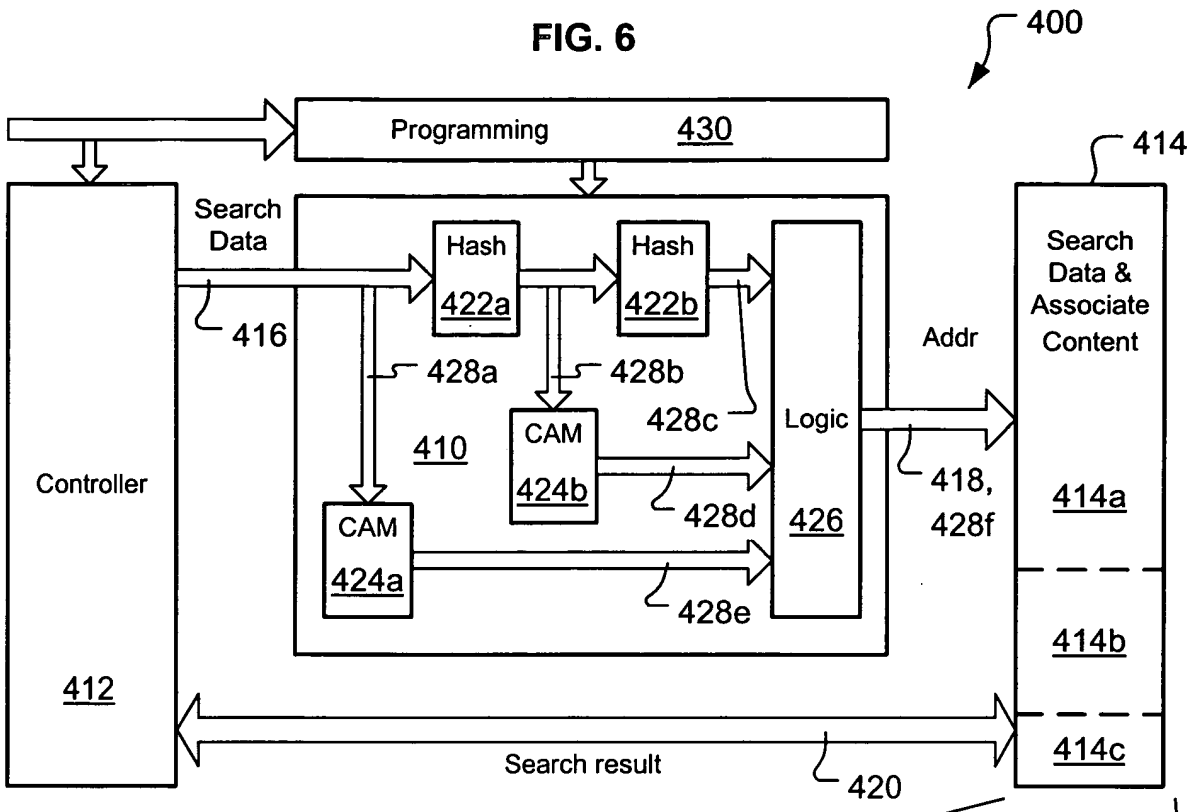
FIG. 5

Paths: a ≥ b ≥ c ≥ d ≥ e ≅ j;

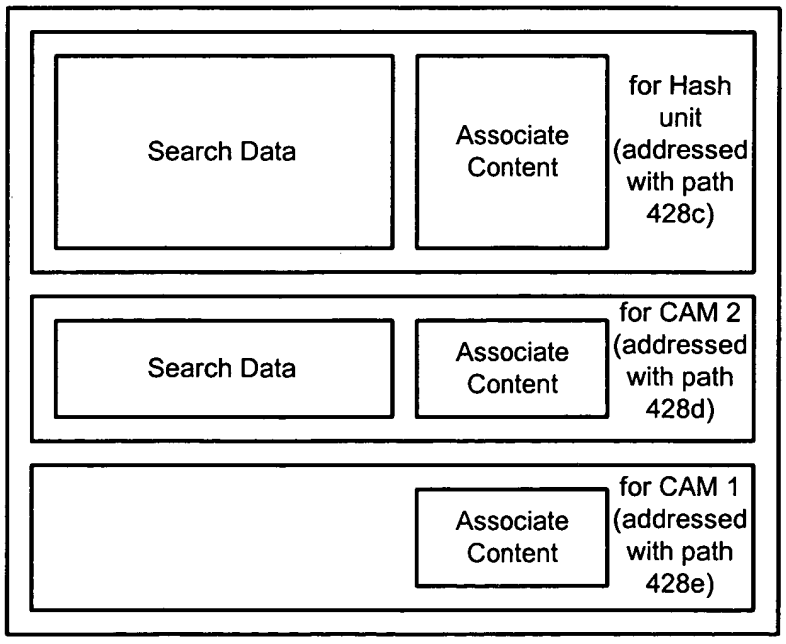
OPPENHEIMER WOLFF & DONNELLY, LLP
Raymond E. Roberts at 650-320-4000
Title: Large Database Search Using Cam and Hash
Docket No.: 60409.300901
Sheet 3 of 10

Tue Oct 30 15:52:36 2001

FIG. 6

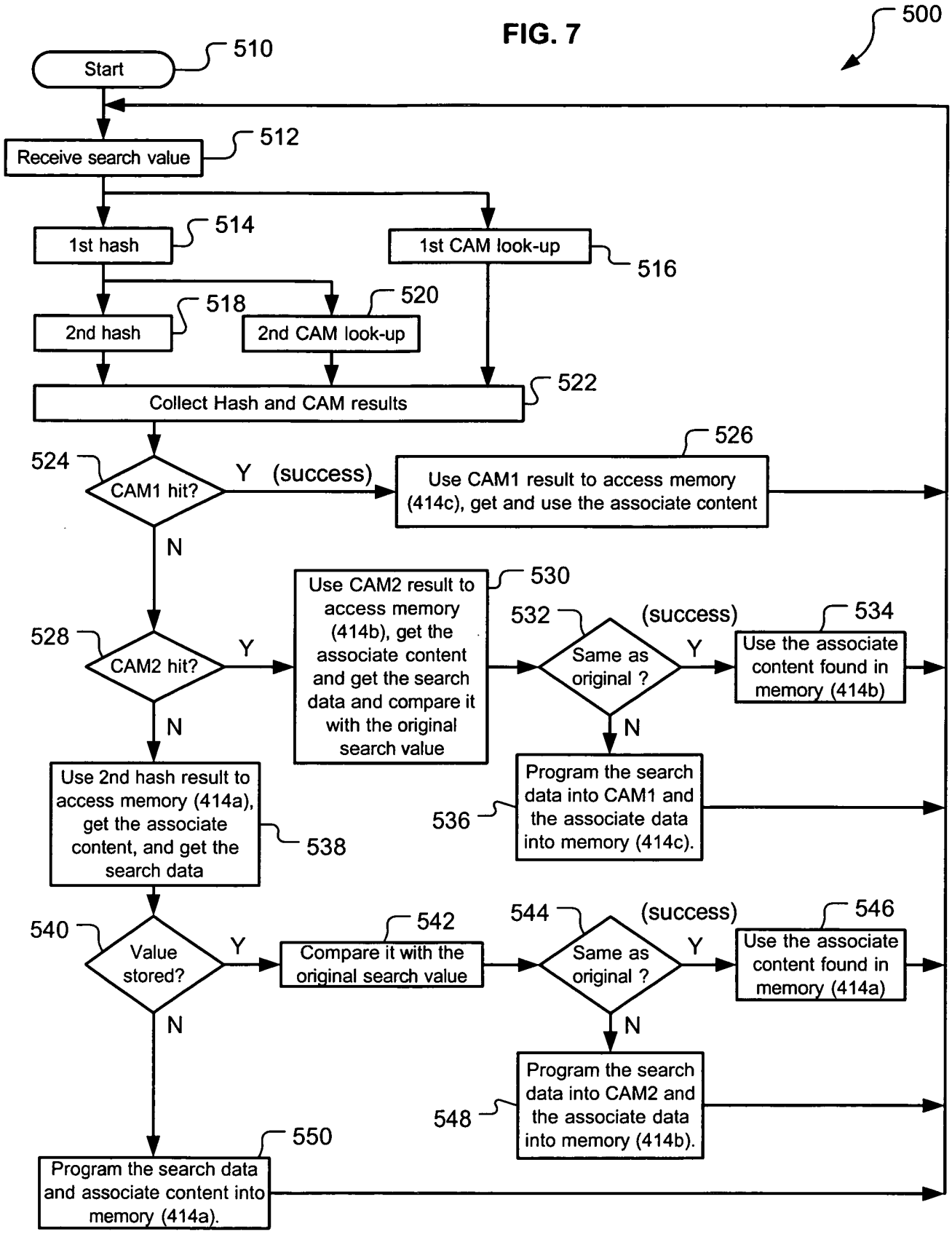


Paths: a ≥ b ≥ c ≅ f;



Search Data and Associate content memory for a 2 level Hash-CAM system. Notice the memory may be composed of five blocks and three distinct sections.

FIG. 7


500
Start
510
Receive search value
512
1st hash
514
1st CAM look-up
516
2nd hash
518
2nd CAM look-up
520
Collect Hash and CAM results
522
524
CAM1 hit?
Y (success)
526
Use CAM1 result to access memory (414c), get and use the associate content
N
528
CAM2 hit?
Y
Use CAM2 result to access memory (414b), get the associate content and get the search data and compare it with the original search value
530
532
Same as original ?
(success)
Y
534
Use the associate content found in memory (414b)
N
536
Program the search data into CAM1 and the associate data into memory (414c).
N
Use 2nd hash result to access memory (414a), get the associate content, and get the search data
538
540
Value stored?
Y
542
Compare it with the original search value
544
Same as original ?
(success)
Y
546
Use the associate content found in memory (414a)
N
548
Program the search data into CAM2 and the associate data into memory (414b).
N
550
Program the search data and associate content into memory (414a).

60409-300901

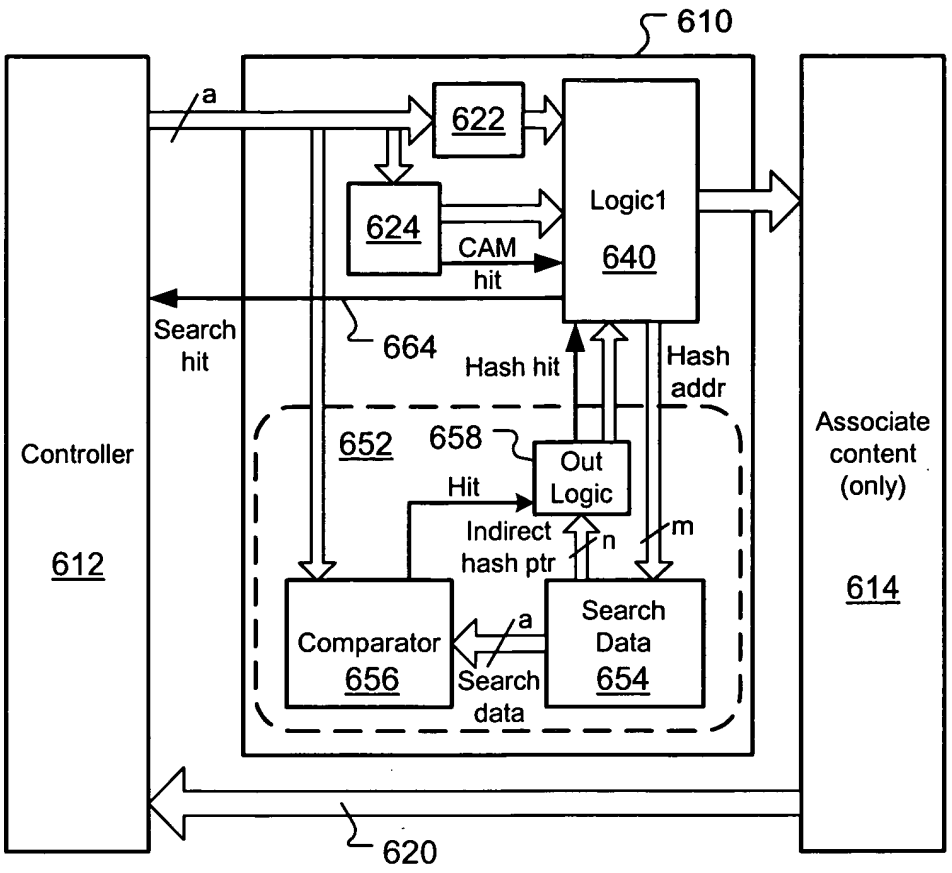


FIG. 8

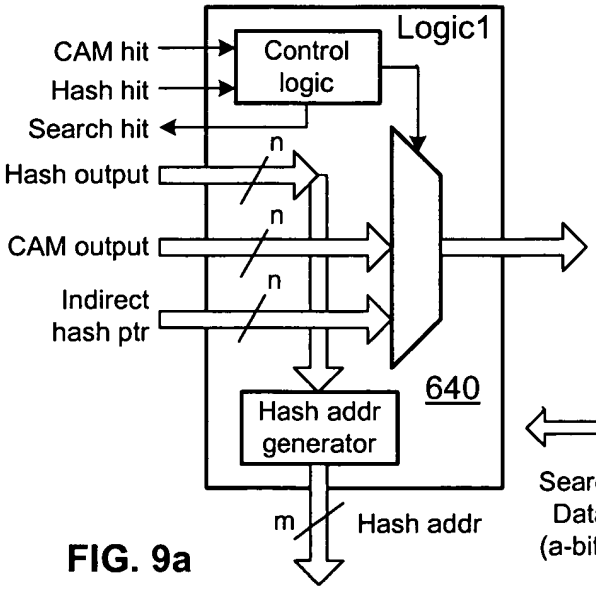
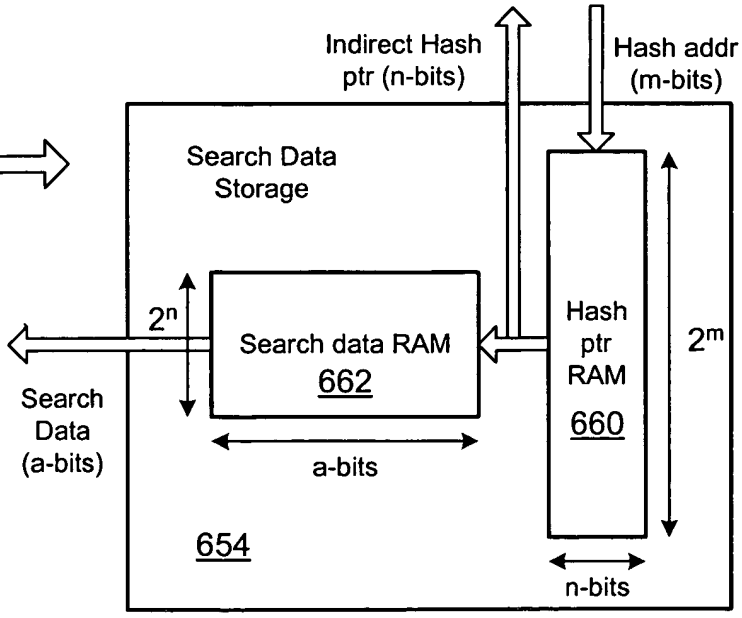


FIG. 9a

FIG. 9b



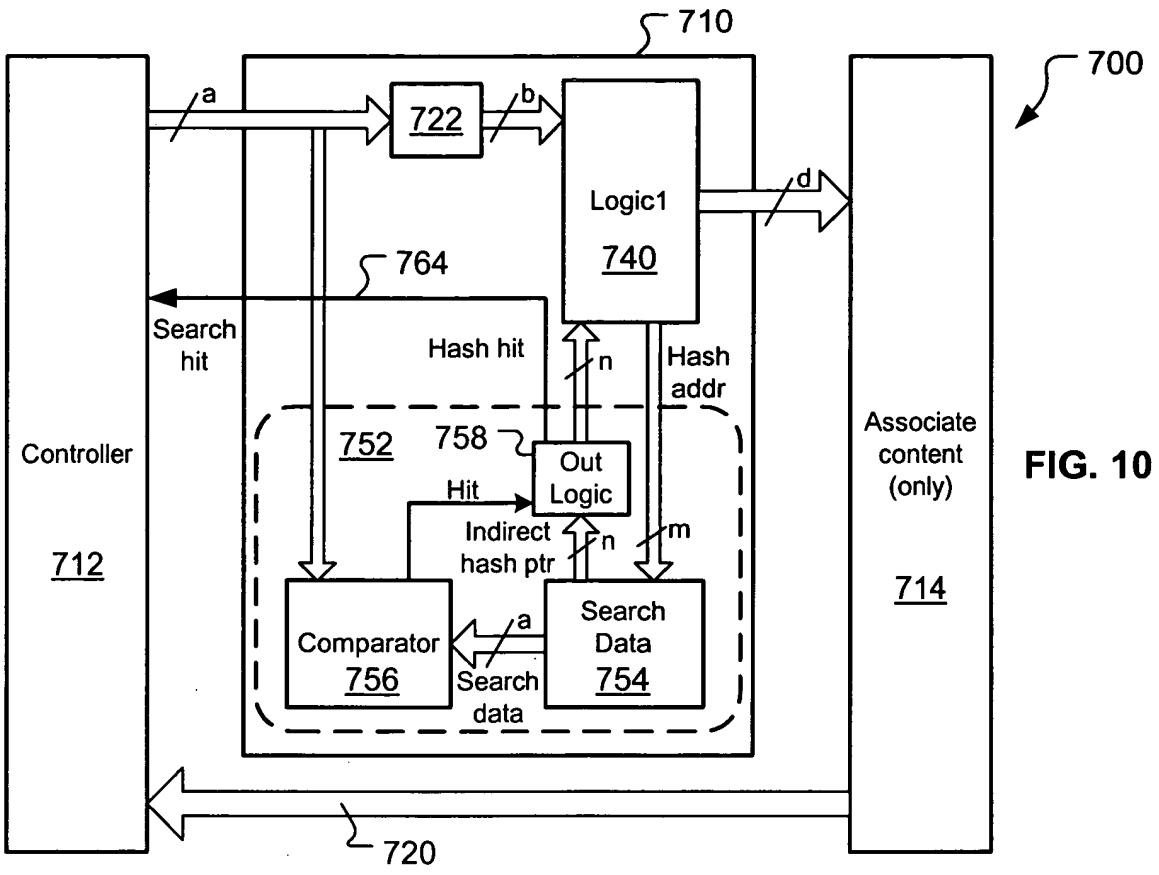


FIG. 10

FIG. 11b

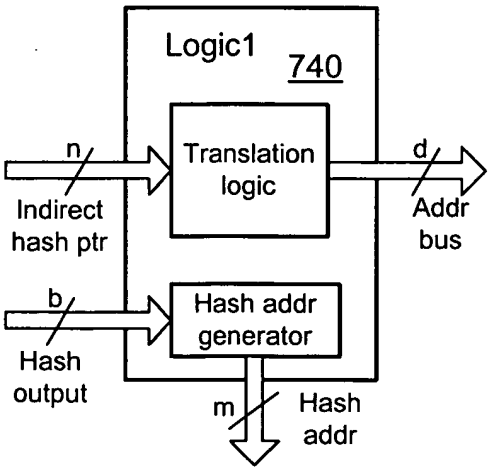
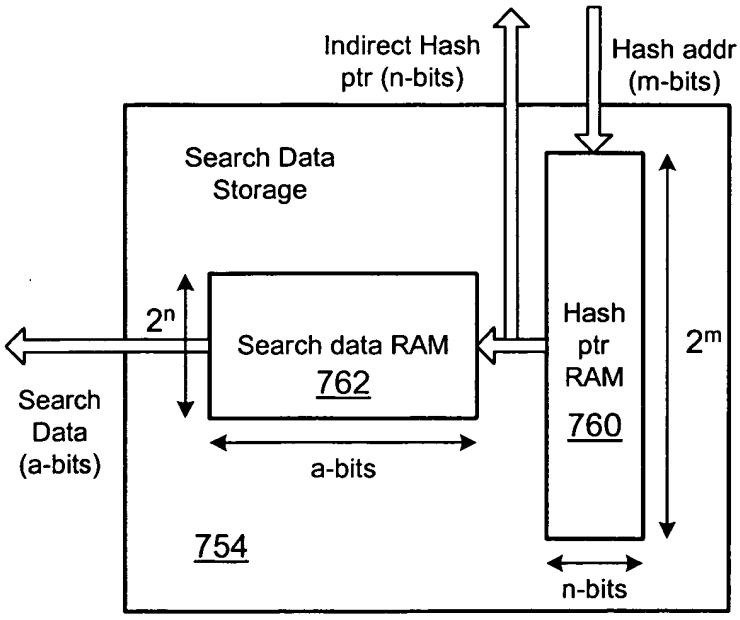


FIG. 11a



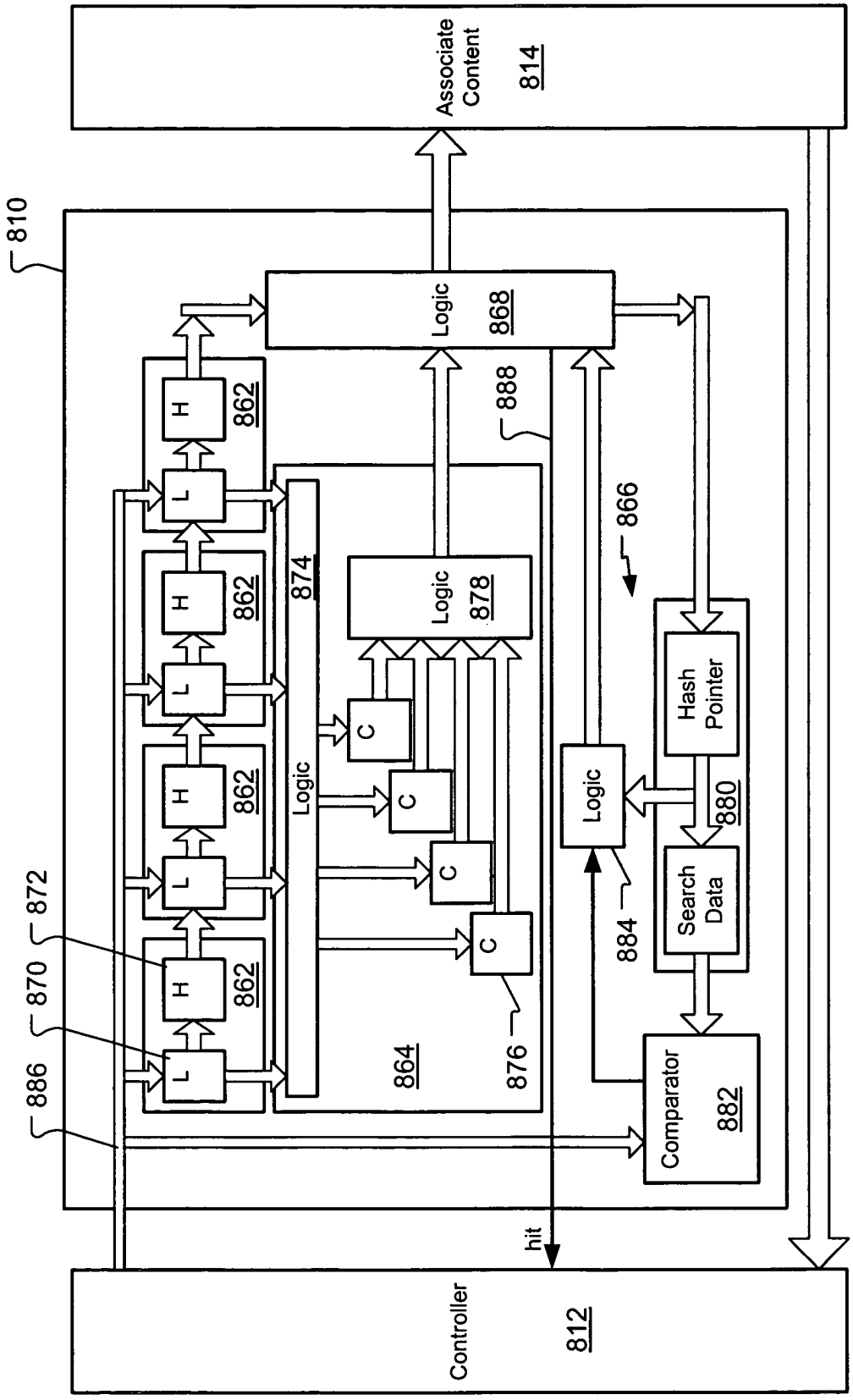
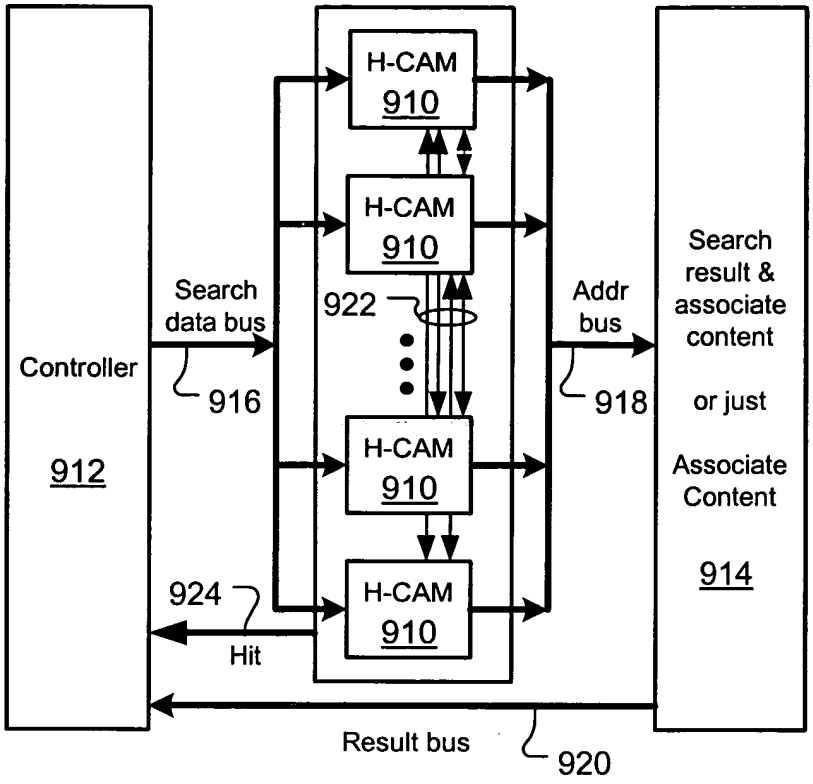


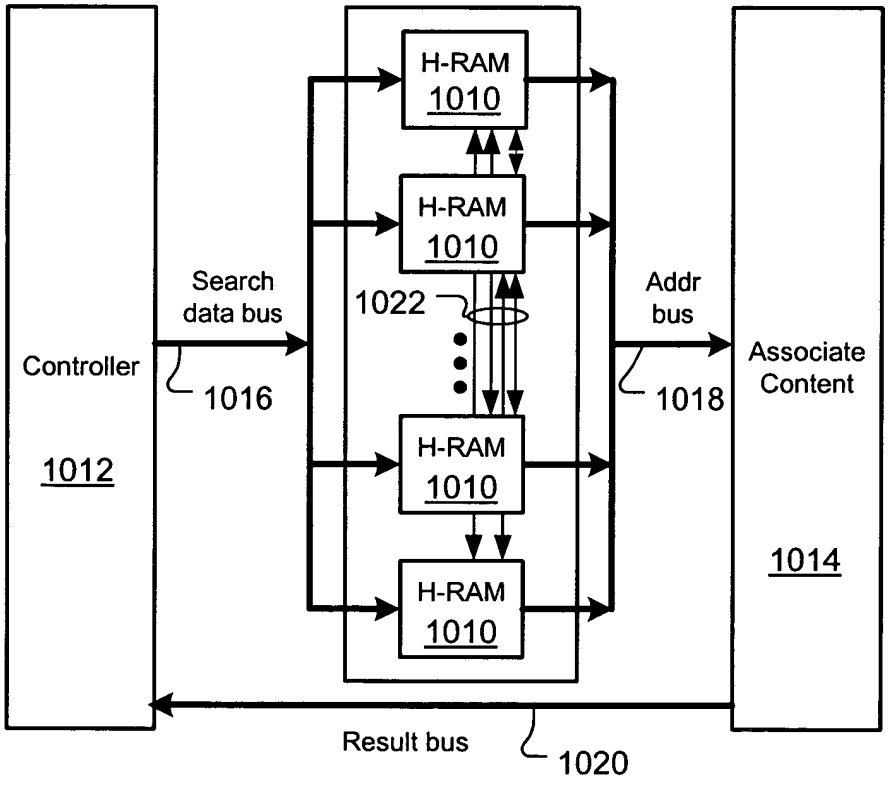
FIG. 12

"60409-300901"



900

FIG. 13



1000

FIG. 14

1D60680 05/26/2005

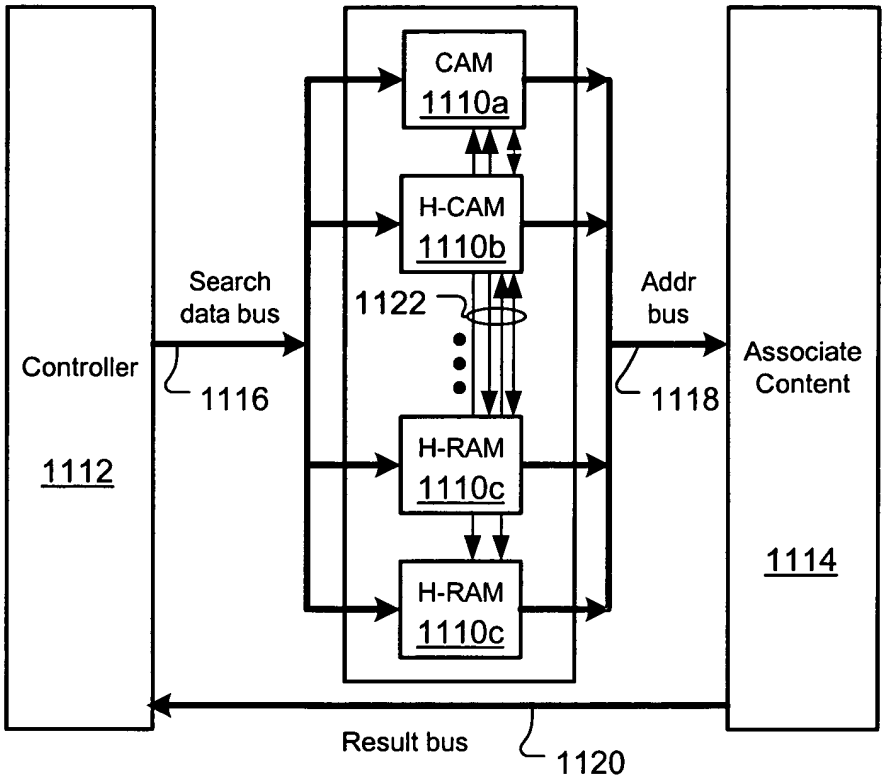

CAM
1110a
H-CAM
1110b
1122
H-RAM
1110c
H-RAM
1110c
Controller
1112
Search
data bus
1116
Addr
bus
1118
Associate
Content
1114
Result bus
1120
1100

FIG. 15

	Hash-based approach (2-way-set-associative) Fig. 1	CAM-based approach Fig. 2	H-CAM-based approach (2-way-set-associative) Fig. 8
ASIC output pins	21	128	128
ASIC input pins	160	32	32
RAM size (est. cost)	2M x 160 ($800)	1M x 32 ($80)	1M x 32 ($80)
CAM size (est. cost)	-	1M x 128 ($3200)	100K x 128 ($320)
Hash Pointer RAM size (est. cost)	-	-	2M x 20 ($100)
Search Data RAM size (est. cost)	-	-	1M x 128 ($320)
Database size (entries) supported	Depends	1M	Depends
Associate content RAM read	2 reads per search	1 read per search	1 read per search
Estimated cost	$800	$3280	$820
Estimated Power consumption	20W	162W	28.5W

Table 1

	Search value (6-digit wide)	Hash 1 output (4-digit wide)	Hash 2 output (2-digit wide)	CAM 1 content	CAM 2 content	Memory content
1	-	-	-	-	-	-
2	324238	7783	63	-	-	-
3	-	-	-	-	-	63: 324238,17
4	578901	6311	63	-	-	63: 324238,17
5	-	-	-	-	100:6311	63: 324238,17 100: 578901,23
6	322413	6311	63	-	100:6311	63: 324238,17 100: 578901,23
7	-	-	-	200:322413	100:6311	63: 324238,17 100: 578901,23 200: - , 86
8	578901	6311	63	200:322413	100:6311	63: 324238,17 100: 578901,23 200: - , 86
9	322413	6311	63	200:322413	100:6311	63: 324238,17 100: 578901,23 200: - , 86
10	324238	7783	63	200:322413	100:6311	63: 324238,17 100: 578901,23 200: - , 86

Table 2

Memory Size and Bandwidth requirement		Old method (Fig. 1)	H-CAM (Fig. 11)
Memory size	**Search Data memory**	8 million entries	1 million entries
	Hash Pointer memory	none	2M pointers
	Total (Mbit)	1024	164
Memory bandwidth	**Reads/search**	8	2 per H-CAM

Table 3

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